UNITED STATES MARINE CORPS

LESSON PLAN

SINGLE-CELL THEORY

INTRODUCTION:

1. Gain Attention. What is the main element in Meteorology that drives all weather? What relationship does this element have with wind flow?

2. Overview. Knowledge of global atmospheric circulation comes from two (2) sources. The first is observing worldwide patterns of pressure and wind and the second is theoretical studies of fluid motion. This period instruction introduces the first "classic" model that was introduced that described global atmospheric circulation.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. Without the aid of the reference, but in accordance with the instruction, demonstrate knowledge and resultant effects of the single-cell theory.

b. Enabling Learning Objective(s). With the aid of references and in accordance with the instruction, explain:

(1) The fundamental concept that the single cell model is based on.

(2) Why the single-cell theory is not sufficient.

4. Method/Media. This period of instruction will be taught using the lecture method with aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".

5. Evaluation. The student shall be evaluated by verbally demonstrating knowledge of the Single-cell theory.

TRANSITION. In the eighteenth century meteorologists derived a theory regarding the circulation of the Earth's atmosphere. The "single-cell" theory, which we assume the Earth's surface is uniformly covered with water, so that differential heating does not come into play.

BODY:

1. Single Cell Model. In 1735, a meteorologist by the name of George Hadley proposed that a large temperature contrast existed between the north and south poles and the Equator. He believed that this temperature contrast created one large convection cell in each hemisphere, as shown in figure 1.

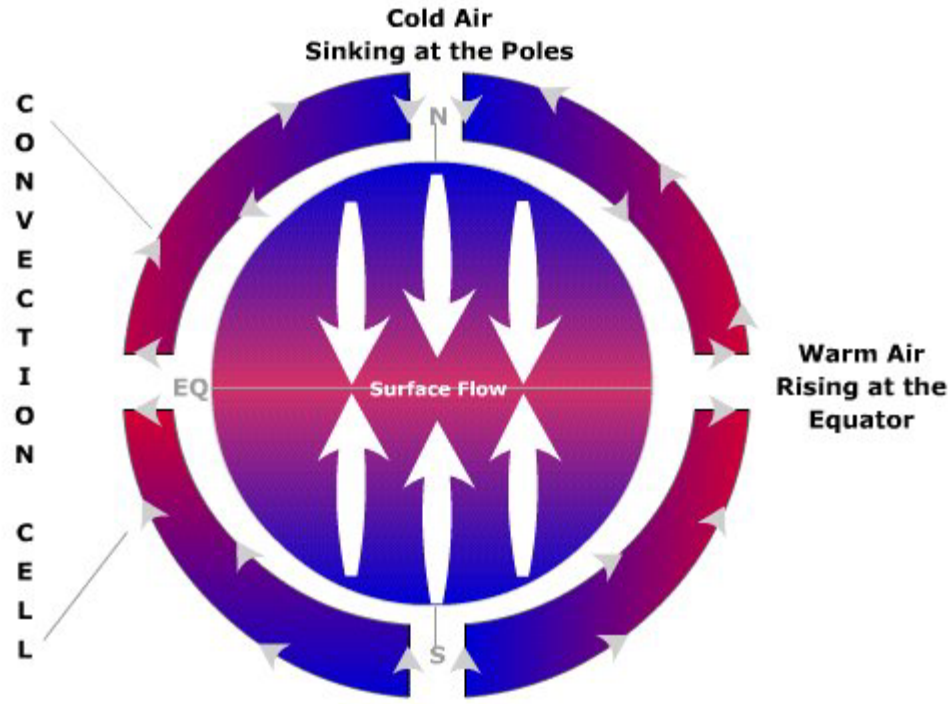

Figure 1 - Single-Cell Circulation Model.

a. Hadley was well aware that solar energy, or energy derived from the sun, initiates the winds. In Hadley's model, intensely heated air at the Equator rises until it reaches the tropopause where it begins to laterally spread out poleward. The upper-level wind flow would eventually reach the poles and begin to subside with the cooler temperatures. As the wind flow reached the surface, it would then laterally spread out equatorward. As the now polar air reached the Equatorial area, it would then begin to rise as it was reheated. Thus the single cell circulation that Hadley proposed was that upper-level air will flow poleward and surface air will flow equatorward.

b. While Hadley's model in correct in principle, meaning hot air rises at the Equator and cold air sinks at the poles, it does not take the rotation of the Earth about its axis into account. Hadley's single cell model better approximates the circulation of a non-rotating planet.

c. As the pressure and wind patterns of the Earth became better known (or observed), it was clear that the single cell model could not create global circulation patterns that were actually being observed. The Three-Cell model (theory), replaced the Single-Cell model that better fits observations, due to the fact that the technology greatly increases every year.

TRANSITION. The single cell theory acts to incorporate the fundamental concept that warm air rises and cold air sinks. It does not, however, consider the fact that the Earth rotates about it axis.

OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time, are there any questions concerning the content that has just been presented?

2. Questions to the Class.

a. QUESTION. How many convection cells does Hadley's model represent?

b. ANSWER. Two, one in each hemisphere.

c. QUESTION. Why is the single cell model not accurate?

d. ANSWER. It does not consider or take into account that the Earth rotates about an axis.

SUMMARY: During this period of instruction, the Single Cell Model was introduced and defined. It was stated that the model represented atmospheric circulation based on the fact that warmer air rises and colder air sinks, but does not include the rotation of the Earth.

REFERENCE.

University of Southern California, Department of Earth Sciences. http://earth.usc.edu/geol150/weather/circulation.html

Ahrens, Donald C. Meteorology Today. 4th Edition. West Publishing Company, 1991.